

Claims

1. Method for transmitting watermark data bits (IWATD) using a spread spectrum, said method including the steps:
- 5 - modulating (BVMOD) said watermark data bits on an encoder pseudo-noise sequence (ENCPNSEQ);
- modulating (FCMOD) said modulated encoder pseudo-noise sequence (WATS) on a carrier frequency ( $f_{ci}$ );
- determining (WATSEF) whether at one or more different
- 10 candidate frequency band positions in a current frame of said audio signal the energy or amplitude level of said audio signal is such that it can mask one or more, respectively, of said modulated carrier frequencies ( $f_{ci}$ ) and, if this is true, notch filtering (WATSEF) said audio
- 15 signal at the corresponding frequency band positions and inserting (WATSEF) at this frequency or at each of these frequencies, respectively, said carrier frequency or one of said carrier frequencies, respectively;
- checking (WATSEF) at which candidate frequency band positions in a frame following said current frame of said audio signal the energy or amplitude level of said audio
- 20 signal is such that it can mask one or more, respectively, of said modulated carrier frequencies ( $f_{ci}$ ), and providing information about the locations of these frequency band positions;
- 25 - transmitting or transferring (TRM) data of said current audio signal frame carrying said watermark data bits together with the information about the locations of the frequency band positions to be used in said frame following said current frame of said audio signal,
- 30 wherein, in the frame following said following frame, no watermark signal carrier is transmitted in the frequency band or bands which have been occupied in said following frame.

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2. Method for transmitting watermark data bits (IWATD) using

a spread spectrum, said method including the steps:

- modulating (BVMOD) said watermark data bits on an encoder pseudo-noise sequence (ENCPNSEQ);
  - modulating (FCMOD) said modulated encoder pseudo-noise sequence (WATS) on a carrier frequency ( $f_{ci}$ );
  - notch filtering (WATSEF) a current frame of said audio signal at frequency band positions which are arranged in a pre-defined pattern across the sequence of frames of said audio signal and inserting (WATSEF) at this frequency band position or at each of these frequency band positions, respectively, in said current frame of said audio signal said carrier frequency or one of said carrier frequencies, respectively,
- wherein said pattern is arranged such that in the frame following said current frame no watermark signal carrier is transmitted in the frequency band or bands which have been occupied in said current frame;
- transmitting or transferring (TRM) data of said current audio signal frame carrying said watermark data bits.

3. Method for regaining watermark data bits (IWATD) embedded in a spread spectrum, whereby the corresponding original watermark data bits were modulated (BVMOD) at encoder side on an encoder pseudo-noise sequence (ENCPNSEQ-1...N) and said modulated encoder pseudo-noise sequence (WATS) was modulated (FCMOD) on a carrier frequency ( $f_{ci}$ ), and wherein at one or more different frequency band positions in a current frame of said audio signal the audio signal was notch filtered and one of said carrier frequencies was inserted instead,
- and wherein a current audio signal frame carrying said watermark data bits was transmitted or transferred together with information about the locations of the frequency band positions used for said carrier frequencies in a frame following said current frame of said audio signal,

wherein, in the frame following said following frame, no watermark signal carrier was transmitted in the frequency band or bands which were occupied in said following frame, said method including the steps:

- 5    - receiving (REC, SYNC) and synchronising said transmitted or transferred audio signal;
- demodulating (BFDEMOD) for a current audio signal frame said carrier frequency or said carrier frequencies, respectively, thereby using said information about the lo-  
10    cation or locations of the frequency band position or positions used for said carrier frequency or frequencies, respectively, which information was attached to the data for a previous frame of said audio signal;
- convolving (DRECMF) said current frame of data of said  
15    audio signal with a time-inversed version (DECPNSEQ\_1...N) of the encoder pseudo-noise sequence;
- determining (DRECMF) from the sign of the peak or the peaks of the corresponding convolution result the value of a bit of said watermark data (OWATD).
- 20    4. Method for regaining watermark data bits (IWATD) embedded in a spread spectrum, whereby the corresponding original watermark data bits were modulated (BVMOD) at encoder side on an encoder pseudo-noise sequence (ENCPNSEQ-1...N)  
25    and said modulated encoder pseudo-noise sequence (WATS) was modulated (FCMOD) on a carrier frequency ( $f_{ci}$ ), and wherein at one or more different frequency band positions in a current frame of said audio signal the audio signal was notch filtered and one of said carrier fre-  
30    quencies was inserted instead, whereby said frequency band positions were arranged in a pre-defined pattern across the sequence of frames of said audio signal, wherein said pattern was arranged such that in the frame following said current frame no watermark signal carrier  
35    was transmitted in the frequency band or bands which were occupied in said current frame, said method including the

steps:

- receiving (REC, SYNC) and synchronising said transmitted or transferred audio signal;
  - demodulating (BFDEMOD) for a current audio signal frame  
5 said carrier frequency or said carrier frequencies, respectively, thereby using the information about said pre-defined pattern;
  - convolving (DRECMF) said current frame of data of said audio signal with a time-inversed version  
10 (DECPNSEQ\_1...N) of the encoder pseudo-noise sequence;
  - determining (DRECMF) from the sign of the peak or the peaks of the corresponding convolution result the value of a bit of said watermark data (OWATD).
- 15 5. Apparatus for transmitting watermark data bits (IWATD) using a spread spectrum, said apparatus including:
- means (BVMOD) for modulating said watermark data bits on an encoder pseudo-noise sequence (ENCPNSEQ);
  - means (FCMOD) for modulating said modulated encoder  
20 pseudo-noise sequence (WATS) on a carrier frequency ( $f_{ci}$ );
  - means (WATSEF) for determining whether at one or more different candidate frequency band positions in a current frame of said audio signal the energy or amplitude level  
25 of said audio signal is such that it can mask one or more, respectively, of said modulated carrier frequencies ( $f_{ci}$ ) and which means (WATSEF), if this is true, notch filter said audio signal at the corresponding frequency band positions and insert at this frequency or at each of  
30 these frequencies, respectively, said carrier frequency or one of said carrier frequencies, respectively, and which means (WATSEF) check at which candidate frequency band positions in a frame following said current frame of said audio signal the energy or amplitude level  
35 of said audio signal is such that it can mask one or more, respectively, of said modulated carrier frequencies

( $f_{ci}$ ), and provide information about the locations of these frequency band positions;

- means (TRM) for transmitting or transferring data of said current audio signal frame carrying said watermark data bits together with the information about the locations of the frequency band positions to be used in said frame following said current frame of said audio signal, wherein, in the frame following said following frame, no watermark signal carrier is transmitted in the frequency band or bands which have been occupied in said following frame.

6. Apparatus for transmitting watermark data bits (IWATD) using a spread spectrum, said apparatus including:

- means (BVMOD) for modulating said watermark data bits on an encoder pseudo-noise sequence (ENCPNSEQ);
- means (FCMOD) for modulating said modulated encoder pseudo-noise sequence (WATS) on a carrier frequency ( $f_{ci}$ );
- means (WATSEF) for notch filtering a current frame of said audio signal at frequency band positions which are arranged in a pre-defined pattern across the sequence of frames of said audio signal, which means (WATSEF) insert at this frequency band position or at each of these frequency band positions, respectively, in said current frame of said audio signal said carrier frequency or one of said carrier frequencies, respectively, wherein said pattern is arranged such that in the frame following said current frame no watermark signal carrier is transmitted in the frequency band or bands which have been occupied in said current frame;
- means (TRM) for transmitting or transferring data of said current audio signal frame carrying said watermark data bits.

7. Apparatus for regaining watermark data bits (IWATD) em-

bedded in a spread spectrum, whereby the corresponding original watermark data bits were modulated (BVMOD) at encoder side on an encoder pseudo-noise sequence (ENCPNSEQ-1...N) and said modulated encoder pseudo-noise sequence (WATS) was modulated (FCMOD) on a carrier frequency ( $f_{ci}$ ),  
and wherein at one or more different frequency band positions in a current frame of said audio signal the audio signal was notch filtered and one of said carrier frequencies was inserted instead,  
and wherein a current audio signal frame carrying said watermark data bits was transmitted or transferred together with information about the locations of the frequency band positions used for said carrier frequencies in a frame following said current frame of said audio signal,  
wherein, in the frame following said following frame, no watermark signal carrier was transmitted in the frequency band or bands which were occupied in said following frame, said apparatus including:  
- means (REC, SYNC) for receiving and synchronising said transmitted or transferred audio signal;  
- means (BFDEMOD) for demodulating for a current audio signal frame said carrier frequency ( $f_{ci}$ ) or said carrier frequencies, respectively, thereby using said information about the location or locations of the frequency band position or positions used for said carrier frequency or frequencies, respectively, which information was attached to the data for a previous frame of said audio signal;  
- means (DRECMF) for convolving said current frame of data of said audio signal with a time-inversed version (DECPNSEQ\_1...N) of the encoder pseudo-noise sequence, which means (DRECMF) determine from the sign of the peak or the peaks of the corresponding convolution result the value of a bit of said watermark data (OWATD).

8. Apparatus for regaining watermark data bits (IWATD) embedded in a spread spectrum, whereby the corresponding original watermark data bits were modulated (BVMOD) at encoder side on an encoder pseudo-noise sequence  
5 (ENCPNSEQ-1...N) and said modulated encoder pseudo-noise sequence (WATS) was modulated (FCMOD) on a carrier frequency ( $f_{ci}$ ),  
and wherein at one or more different frequency band positions in a current frame of said audio signal the audio  
10 signal was notch filtered and one of said carrier frequencies was inserted instead, whereby said frequency band positions were arranged in a pre-defined pattern across the sequence of frames of said audio signal, wherein said pattern was arranged such that in the frame  
15 following said current frame no watermark signal carrier was transmitted in the frequency band or bands which were occupied in said current frame, said apparatus including:
- means (REC, SYNC) for receiving and synchronising said transmitted or transferred audio signal;
  - 20 - means (BFDEMOD) for demodulating for a current audio signal frame said carrier frequency ( $f_{ci}$ ) or said carrier frequencies, respectively, thereby using the information about said pre-defined pattern;
  - means (DRECMF) for convolving said current frame of data  
25 of said audio signal with a time-inversed version (DECPNSEQ\_1...N) of the encoder pseudo-noise sequence, which means (DRECMF) determine from the sign of the peak or the peaks of the corresponding convolution result the value of a bit of said watermark data (OWATD).
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9. Method according to claim 1 or 2 or apparatus according to claim 5 or 6, wherein the power or amplitude level of said modulated carrier frequency or frequencies ( $f_{ci}$ ) is made such that it is masked by the energy or amplitude  
35 level of said audio signal at the corresponding frequency or frequencies, respectively.